Chapter 13

Lead Toxicity on Reproductive Health, Fetal Development, and Breast Milk

Content:

Introduction

Lead is ubiquitous in the human environment as a result of industrialization. Lead has no known physiologic value, and has long been recognized as a reproductive toxin in both men and women. Because the typical blood lead level among adults today is lower then in the past, it is less likely to cause extreme effects on reproductive health such as miscarriage or stillbirth. However, the effects of maternal and infant prenatal and postpartum blood lead levels on a child continue to be of concern, and maternal lead exposure and lead poisoning history should be considered in prenatal care assessments.

Today, lead exposure of adults that can affect reproductive health and pregnancy generally occurs in the workplace. Toxic BLLs should not occur if work place exposures are in compliance with Occupation Safety and Health Administration regulations (for more information on workplace exposure and adult blood lead poisoning, contact the Bureau of Occupational Health, Wisconsin Division of Public Health (608-266-9383) or OSHA at www.osha.gov.

As in children, the majority (70-85%) of lead in the adult body is stored in bones and teeth, and the remaining in blood and soft tissue. Lead stored in bones has a long half-life (20-30 years) and can be mobilized into blood and soft tissues during times of physiologic stress, including pregnancy, and lactation. Lead is similar in chemical structure to calcium, and competes with it for absorption in the gastrointestional tract and deposition in bone.

Lead Toxicity and Reproductive Health

Historical literature extensively documents that chronic, excessive exposure to lead was associated with increased rates of infertility, miscarriage, stillbirth, and poor infant outcomes. These harmful effects were associated with blood lead levels BLLs of 80μg/dL or more. BLLs in this range are most always associated with workplace exposure. It is unlikely that lead-based paint exposure in a home would result in BLLs in adults this high unless extensive remodeling or abatement was being done while the pregnant woman was living there.

In adult males, chronic lead exposure can result in decreased sex drive, impotence, and sterility. Abnormalities in sperm, including count and motility, have also been found. There is no consistent evidence that male lead exposure gives rise to negative effects on a fetus of a subsequent pregnancy.

The toxicity of lead on adult female reproduction is decreased fertility, the ability to sustain pregnancy, and pregnancy outcomes. High levels of lead exposure, usually associated with acute exposure, can result in stillbirth or miscarriage. Lower blood lead levels, resulting from chronic low-level exposure or mobilization of bone lead during pregnancy, is associated with low birth weight and pre-term delivery.

Research indicates that exposure to lead during pregnancy is only one source from which a fetus can be exposed to lead. Pregnancy and breastfeeding can cause a state of physiologic stress that increases bone turnover of lead. Lead stored in the bone as a result of childhood lead poisoning moves into the blood, increasing the

mother's blood lead level and passing to the fetus. Pregnancy related hormonal changes affect calcium metabolism and also cause lead to leave the bone and enter the blood. Whatever the cause, whenever maternal blood lead becomes elevated, it is available to the fetus and can negatively impact fetal development.

Effects on Fetal and Infant Development

Evidence is clear that in utero exposure to low levels of lead can affect infant and child neurodevelopment. Significantly lower scores on the Bayley Mental Development Index (BMDI)[1] were found among children with pre-natal exposure to lead. Other research has found that young children with pre-natal lead exposure have lower scores on verbal IQ components, impairment in hearing and motor development, and increases in learning disabilities and attention deficit disorders.

Associations between maternal lead exposure, even at low levels, and decreased birth weight or length of gestation have been consistent. There is also some evidence of increased risk for pregnancy related hypertension. These outcomes were noted with maternal BLLs as low as 12 μg/dL.

Maternal Transfer of Lead to the Fetus

Lead is tightly bound to red blood cells, enhancing transfer from maternal circulation through the placenta to the fetus. Placental transfer begins as early as the 12th week of gestation. As in adults, the lead can be found in fetal blood, soft tissue, and bone. The fetus is more sensitive to lead because the fetal blood-brain barrier is more permeable, the developing central nervous system is more vulnerable, and the fetus has less bone tissue for sequestering lead. Fetal exposure to lead is usually determined by measuring lead from umbilical cord blood samples taken at birth. These samples are highly correlated with maternal blood levels, with fetal BLLs estimated to be 80 to 90 percent of the maternal levels.

Prenatal Assessment & Intervention

Assessment of exposure to lead should be part of the health care provider's plan of prenatal care. Initial assessment should include obtaining a history on potential sources of lead exposure, including childhood exposures (Figure 9.1). If this initial assessment indicates possible lead exposure, it is prudent to obtain a blood lead level. In light of the 1991 Centers for Disease Control and Prevention recommendation for children, the corresponding "level of concern" for pregnant women would be a blood lead level of 10 μg/dL or more.

[1] The BMDI assesses fine motor function, visually directed reaching, social responsiveness in 6-month-old infants, and fine motor function, language, and imitation in 18-month-old children.

Figure 13.1

Pre-Natal Assessment of Maternal Lead Exposure

- Home environment—lead paint, lead dust generated from remodeling, lead in water, lead contamination of food
- Lead exposure in the workplace or hobbies. NOTE—also inquire about other family members' exposures since lead dust can be carried home on clothing or vehicle upholstery
- The pregnant woman's own childhood lead exposure, especially a significant lead poisoning episode
- Past or current pica practices, e.g., eating clay, dirt, or paint chips
- Use of traditional or home remedies which may contain lead-based substances

Follow-up intervention should then be directed toward:

- ✓ Specific activities to reduce environmental exposure, e.g., changes in work placement or work practices, evaluation of lead-safe renovation practices in the home
- ✓ Nutrition counseling to ensure that dietary intake of iron and calcium is adequate for pregnancy (1200 mg/day calcium and 30 mg/day iron) and to decrease lead toxicity
- ✓ General health education to provide the pregnant woman and her family with the information needed to maintain a lead-safe home
- ✓ Monitoring maternal blood lead levels through pregnancy if indicated

Chelation is ***not*** indicated during pregnancy unless there are overriding concerns about the pregnant woman's own health. Chelation will produce a temporary significant increase in maternal blood lead that could increase the fetal absorption of lead. Currently available chelating agents have also demonstrated teratogenic effects in some animal studies.

Lead in Breast Milk

The concentration of lead in breast milk is linked to the concentration of lead in the maternal blood. The total amount of lead in breast milk is stable over time and is determined by the mother's lifetime exposure and body burden of lead. The contribution of lead in breast milk to infant exposure to lead is usually less important than prenatal and other postnatal exposures. The benefits of breastfeeding will most often outweigh concerns about infant exposure to lead from breast milk.

Routine blood lead screening of breast feeding mothers to determine infant risk is not necessary.

The amount of any substance transferred from blood to breast milk is dependent on its solubility and binding affinities. Lead is an ionized metal, bound tightly to red blood cells, and is found at low levels in the plasma. These characteristics inhibit transfer of lead into breast milk.

The *milk/plasma* ratio gives an indication of the level of a substance in breast milk compared to the level in the mother's blood. A milk/plasma ratio equal to or greater than 1/1 can be assumed to result in a significant dose to the infant. The milk/plasma ratio of lead is 0.2/1. This means that little of the lead in the mother's blood will be transferred into the breast milk.

The *half-life* of a substance chemical gives an indication of the length of time it would exist after a specific level of exposure. This idea is often used when evaluating the effect of a dose of a specific medication or a poisoning incident. The long half-life of lead in breast milk (13 weeks) is due to bone stores of lead which can be mobilized, move into the blood, and become available for transfer into breast milk. However, the very low milk/plasma ratio of lead (.2/1), combined with the long half-life means that while lead may be present in breast milk for a long period of time, it will be present in very small amounts.

Most recent studies measuring lead in breast milk of the general population have found the average level has been in the lower end of a range from 0.1 to 2 μg/dL (100 cc) of breast milk. The decline in these averages is believed to correspond with the decline in BLLs of the general population.

At this time, there is no laboratory in Wisconsin that can do routine analysis of lead content in breast milk. For more information, health care providers can call the State Laboratory of Hygiene (608-224-6251).

Infant Dose of Lead from Breast Milk

Using the lower average amount of lead in breast milk (0.1 μg/dL) and an average intake of breast milk of 700 cc (24 oz.) a daily dose of 0.7μg of lead/day can be estimated. This would be considered a low level of dietary lead intake, and a considerable drop from the 1988 FDA Total Diet Study estimate of infants' daily lead intake of approximately 5 μg. The amount of lead in breast milk will be relatively stable during nursing.

Commercially prepared ready-to-feed formula has the same amount of lead as breast milk. Concentrated or powdered formulas that require dilution would reflect the lead content of the water used. If the tap water had a high lead content, the infant could receive a substantially higher dose of dietary lead from formula than from breast milk. Any family living in pre-1978 housing is advised to run tap water in the morning for 2-3 minutes or until it gets icy cold before using water for food, beverage, or formula preparation. If concern about content of lead in water is high, bottled water should be used to prepare formula.

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